AN EXAMINATION OF PROJECT MANAGEMENT AND CONTROL REQUIREMENTS AND ALTERNATIVES AT FNOC

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THESIS

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AND CONTROL REQUIREMENTS AND
ALTERNATIVES AT FNOC

by

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Thesis Advisor: N. R. Lyons

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An Examination of Project Management and Control Requirements and Alternatives at FNOC

by

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from the

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The need for a project information and control system at FNOC was examined. Personal interviews and checklists were used to determine user requirements. Several manual and automated alternatives were presented. The author concluded that the purchase of a software package, would in all probability, be the most efficient and effective alternative. Several packages were evaluated and 3 packages were finally presented for more extensive review by FNOC staff.

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PREFACE

Throughout this thesis the reader will find three categories of statements. **Scientific facts** are those statements that are supported by scientific research in the field. These statements can be identified by a direct reference. **Authors opinions** are specifically identified as such. All other statements can be classified as **General management lore.** This type of statement refers to generally accepted theory in the management field; however it is unsupported by scientic research.

I. INTRODUCTION

In an environment characterized by increased numbers of projects, drastic increases in demands for information, and strong limitations on personnel, computer, and financial resources, Fleet Numerical Oceanographic Central (FNOC), must look at alternative courses of action to maintain an effective level of performance in project management.

It is the intent of the author to examine the need and information requirements for, project information and control system (PICS) at FNOC. This system should not only provide for the flow of pertinent project information to top management; but also assist the project manager and other middle managers in estimating, assignment, and scheduling of project tasks and resources. Alternative courses of action will be identified and available software packages examined, to determine their capability of meeting those requirements.

This document will provide to FNOC management assistance in selecting the appropriate course of action as well as providing a preliminary analysis of user requirements.

Prior to examination of FNOC's project management needs, a review of the literature relevant to project management

will be provided. Specifically, there will be an examination of several of the problems associated with software project management. An awareness of these problems will assist the project manager in visualizing the importance of effective project control.

II. REVIEW OF PROBLEMS IN SOFTWARE PROJECT MANAGEMENT

An increasing percentage of DOD monies are allocated for direct software acquisition or embedded software. In 1977, the United States government estimated the cost of software development, testing, and maintenance to be about $4 billion per year. At that time the government owned approximately $25 billion worth of currently used software. [Ref. 1] Overruns of 100% in both cost and delivery time have not been uncommon occurrences in software projects; and in fact, there have been cases of total failure to develop systems.

There has been a great deal of attention and speculation as to the cause of these problems. It is the author's contention that effective project management on the part of the contracting project manager can minimize and perhaps eliminate most of these problem areas.

A review of the literature surfaced several problem areas in software project management. These problems are presented here, together with information for the project manager who desires to minimize the risk of project failure. Certainly the awareness alone, of potential problems,

will increase the effectiveness of the project manager, and provide direction toward project success.

PROBLEM:

Poor accountability and control structure, such as:

* inappropriate measures of effectiveness
* minimizing development costs and schedule
* emphasis on percent coded

The first method of control starts with the organizational structure. Usually the project organization is set up to meet a specific objective and it dissolves after it has been accomplished. This, in itself can create a problem. The manager may not be fully aware of the skills of the programming teams. The host organization must therefore strive to maintain accurate documentation as to those abilities.

Managers must also decide on a mangement system. There are many automated management control systems available to assist a project manager; however, it should be remembered that they must fit the organization, and that simply because they have been used with great success by others , does not guarantee their success in all structures or projects. This

is a point that many managers fail to take into account when they are looking for that magic control method. In matching a method to the organization the manager must take into account such things as whether or not project management is linear or matrix oriented, what item the organization is most interested in tracking, and what levels of reporting are required.

Establishment of a project control room to centralize information needed by the project team might prove to be of value to the organization. Some of these items include: documentation, master schedules, status reports, change authorizations, budget, systems flow charts, edit rules, and user training information. Consideration might also be given to the establishment of a project control secretary position.

Emphasis on percent coded tends to get people coding too early and key activities such as requirements and design validation, test planning and draft of user documents are neglected. It is also true that percent coded is not indicative of where the project is relative to the schedule. It is extremely subjective. To combat this problem, key milestones should be set. These must be measurable milestones. For example, milestone 1 might be acceptance/approval of design

criteria by the user. Involvement of the user early in the project and throughout its existence will help to keep the project on track and hopefully surface user problems early in the project.

Structured programming techniques; specifically top-down design, provides a procedure for organizing and developing the control structure of a program in a way which focuses attention early to the critical issues of integration and interface identification and definition.

PROBLEM:

Software requirements specifications
(if they exist)
are often ambiguous.

These requirements must be written by personnel knowledgable in both the systems requirements and software development. This is often not the case, especially where embedded software is involved.

Technology can be of assistance here. Machine analyzable software requirements systems are available. The pioneer in this technology was ISDOS, developed by Teichroew at the University of Michigan [Ref. 2]. although it was developed

primarily for business systems applications; the United States Air Force is currently using and sponsoring extensions to ISDOS under the computer aided requirements analysis (CARA) program. Another even more extensive and powerful system is one developed under the software requirements engineering program (SREP) by TRW for the United States Army Ballistic Missile Defense Advanced Technology Center. Even these automated systems have limitations however; the capabilities to represent large file processing and man-machine interactions are limited. They are a start however.

Often a project manager will inherit a project which is not adequately defined. Realizing this and taking immediate steps to remedy the problem is necessary to project success. The extra time spent at this point will pay off in the end. Because of the nature of software development, errors detected early in the cycle are less costly then those discovered in later phases, Figure 1 [Ref. 3]. A project manager must avoid the temptation to allow detailed design and coding to begin prior to establishment of user requirementts and an overall plan. The extra time spent in the definition and design phase will be time well spent if it minimizes the likelihood of problems in later phases.

ERROR DETECTION AND DESIGN PHASE

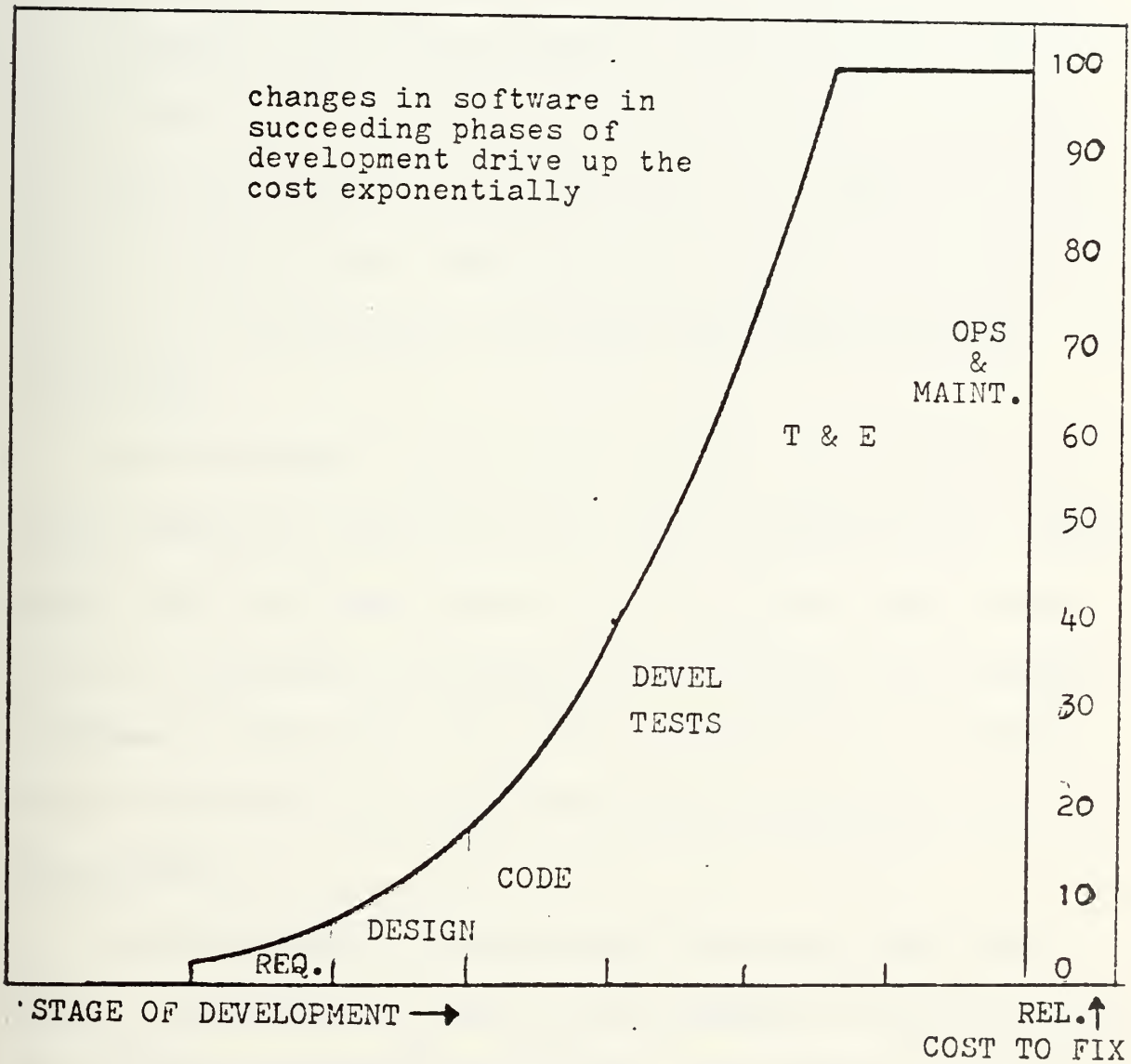

FIGURE 1

PROBLEM:

Software testing and reliability activities are often not considered until the code has been run for the first time and found not to work.

In general the cost of testing, 40%-50% of the devlopment effort, is due to the high cost of reworking the code at this late phase of the cycle [Ref. 4]. There is a great deal of wasted effort resulting from the lack of an advanced test plan to efficiently and effectively guide testing activities.

The development people must consider the testability of their design and ensure that code can be exhaustively tested before the next higher level of code is added. Early location and correction of errors results in much more reliable programs. A solid test plan should provide for an independent validation team to be established at the beginning of the project.

The consequences of undetected errors can range from minor to disastrous. A well known example of the latter was the Mariner 1 interplanetary probe. The absence of one bar over a letter in a computational equation resulted in a

unrecoverable problem, left no alternative but to destruct the $18.5 million dollar rocket shortly after launch. [Ref. 5]

Reliability can be improved by imposing standards on programming style for all code written. Structured programming has a lot to contibute in this area. Structured programming involves dividing a complex program into progressively smaller modules, each of which has a well defined task. The most refined modules are small and logically straight forward. They have limited control structures and one entry and exit point. The conciseness of the modules allows the programmer to use formal mathematics to prove the correctness of the code.

PROBLEM:

Cost estimates in software projects are often incomplete and grossly inaccurate.

There is always the element of risk, especially on projects that push the state of the art. Estimating hardware costs has followed established methods, software on the other hand, is seldom handed to a software estimating group. In fact, software estimating seldom follows any scientific

procedures, with perhaps the exception of those organizations utilizing PERT/CPM*.

The DOD is currently evaluating macro and micro techniques for estimating resources required for ADP projects. The macro technique provides an overall lump sum estimate of manpower and costing factors for the entire systems life cycle. The micro technique provides detailed manpower and costing for each phase of the life cycle [Ref. 6].

Studies by industry have concluded that there are no simple universal rules for costing software accurately and that to estimate it accurately it is neccesssary to understand the nature of the individual program [Ref. 7].

It would appear that, the problem with software cost estimates is that until we have more standardization of procedures in the software industry, the estimates will continue to be grossly inaccurate due in part to the varying programming methods.

One pitfall to avoid in worrying about software costs is that of concentrating too much on reducing software development costs. What really needs to be reduced is software life cycle costs. Instead, we too often find project managers

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*For additional information on PERT/CPM see Cleland, D.L. and King, W.R., Systems Analysis And Project Management, McGraw-Hill: 1968, chapter 15.

making a lot of trade-offs during the software development to meet schedule and cost constraints. Many of those trade-offs trade maintainability for speed of development.

In a discussion during the 1973 Symposium on the High Cost of Software, it was pointed out that the avionics software in the Air Force cost something like $75 per instruction to develop; however, the maintenance* of the software had costs up to $4000 per instruction [Ref. 8].

The trend projected through 1985 is for software costs to continue to rise [Ref. 9]. In part, this is due to an increase in size and complexity of projects and an overall increase in the rate of technological change. The industry is currently pouring R&D money into exploration of automated methods. Some progress has been made in this area; however in the author's opinion, it will be some time before wide spread use.

PROBLEM: Schedule slippage

*Maintenance includes all costs after the initial development effort associated with keeping the software in operation (including revisions/upgrades).

Schedule slippage results for a number of reasons. Notable among them is personnel related problems. Skill levels among programmers vary greatly, also the amount of time neccessary to program in different languages varies. These factors together with the degree of complexity of the system required, must be considered by the project manager in making the schedule estimate. Most often a project manager inherits a project for which these estimates have been made prior to the assignment of the project team and the project manager will have to make adjustments and recommednations to deal with inappropriate estimates.

Project managers must rid themselves of the idea that if they get behind schedule, adding more programming staff will solve their problem. On the contrary, in many instances it will no doubt have quite the opposite affect That is, the new staff will have to be brought up to speed and this entails pulling experienced programmers off the job for this purpose, resulting in even greater delays. Brooks' Law states: "Adding manpower to a late software project makes it later " [Ref. 10].

It is obvious that the preceding problems are not independent, and that difficulty in any one of them has a significant impact on each of the others.

In summary, the difference between software project successes and failures has most often been traced to good or poor practices in software management. These problems can be divided into the following three major areas:

POOR PLANNING: Generally this leads to large amounts of wasted effort and idle time because of tasks being unneceassarily performed, overdone, poorly synchronized, or poorly interfaced.

POOR CONTROL: A plan is useless when it is not kept up to date and used to manage the project. Also, the selection of the correct control method for the organization is critical for success.

POOR RESOURCE ESTIMATION: Without a firm idea of how much time and effort a task should take, the manager is in a poor position to exercise control. Improper assignment of personnel to tasks can cause cost and schedule overruns.

In short, the key to project success lies with the management team and the efforts they make to establish project control. In the following chapters, the author will examine FNOC's project management needs in relation to these and other considerations.

III. OVERVIEW OF FNOC OPERATIONS

FNOC provides a wide spectrum of numerical , meterological, and oceanographic products to worldwide users on a real-time basis. A multi-mainframe computer center is used to execute report processing, analysis, prediction, display and research jobs as a major part of the command's mission. A standard sequence of scheduled jobs known as the operational run (OPS RUN) is processed every 12 hours to accomplish a complete global meterological and oceanographic analysis and prognosis cycle. A database of current environmental observations and a complete set of climatological information is used. The goal of the OPS RUN being to provide analysis and forecast fields and data for transmission to DOD facilities and users as soon as possible after the receipt of raw observations.

FNOC is an integral part of the naval oceanographic and meterological support system. See Figure 2. Environmental, meterological, oceanographic observations (raw data) and requests for services come into FNOC, the primary production facility, via the Automated Weather Network (AWN), AUTODIN, AMSAT, or the Suitland data line. The raw data is quality

checked, sorted, and edited by computer programs, after which the analysis, prognosis, and applications programs are run and the output processed and placed in the integrated database.

A sophisticated series of prediction programs generate forecast variables such as wind, temperature, pressure, moisture, and sea heights, to provide the fleet with a four dimensional measure of the air-ocean environment in which they operate. These products are distributed to the four weather centrals (Pearl,Guam Norfolk, and Rota) via the Naval Environmental Data Network (NEDN) and the Naval Environmental Display System (NEDS). The weather centrals tailor these products before disseminating them to end users. In some cases FNOC provides environmental products directly to the end users.

The products produced by FNOC are of two basic types; routine/ scheduled or tailored. Special requests for tailored products are based on changing fleet or other operational committments. These products are transmitted via the telecommunications system. Figure 3 is a listing of some of the products currently provided by FNOC. A primary emphasis in oceanographic modeling is support of antisubmarine warfare forces. FNOC provides fleet units with expected

detection ranges for each of their acoustic sensor systems, no matter where they are. Currently, satelite processing is becoming the focus of attention, as a means of providing a more accurate database.

To provide all these services; FNOC maintains twenty-four hour computer center operations, manned by military and civilian personnel. There is considerable development of advanced techniques and capabilities in data processing, ocean and atmospheric analysis, prediction, display, applications and communications. There is continual planning and implementation of computer systems upgrades.

The project approach is frequently used to meet new and changing requirements at FNOC; hence, there is a sound reason for seeking to optimize the project management procedures and controls.

NAVAL OCEANOGRAPHY COMMAND ORGANIZATION

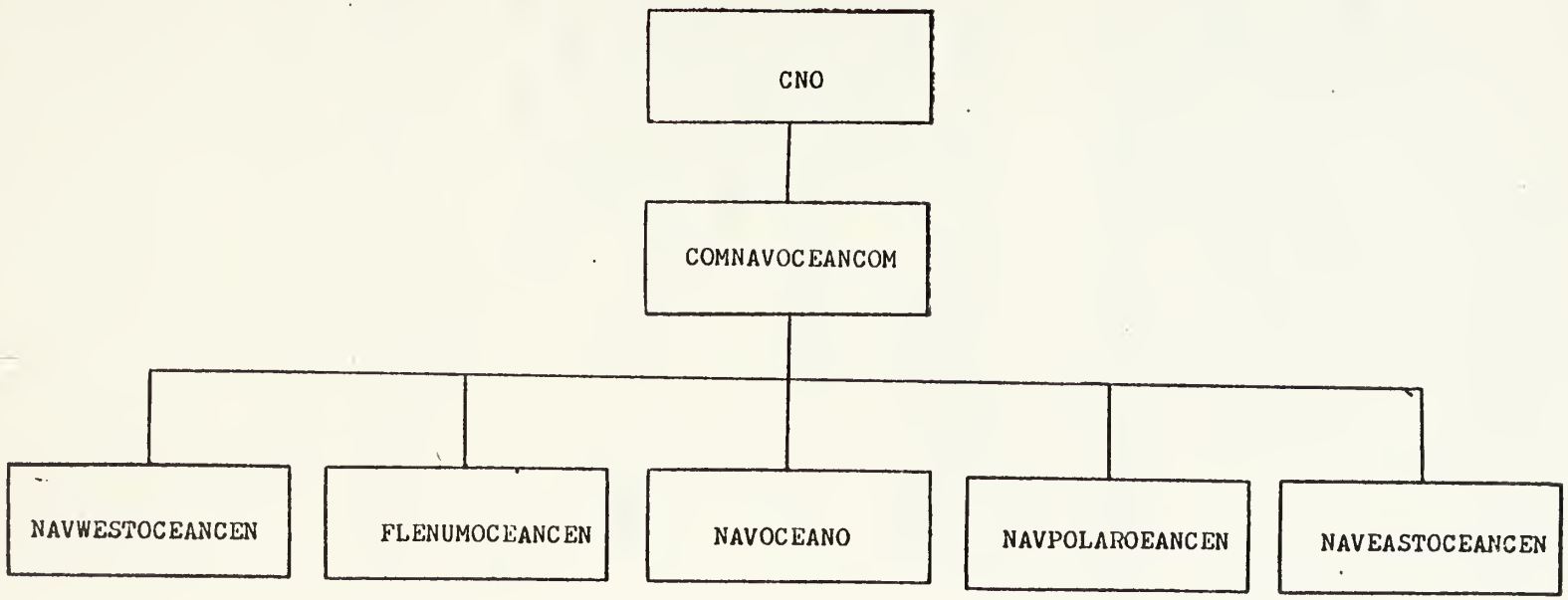

FIGURE 2

FNOC PRODUCTS

ROUTINE

area forecasts
wind and sea warnings
terminal and local forecasts
oceanographic outlooks
acoustic predictions
analysis and prognosis for atmosphere and ocean

TAILORED

optimum track ship routes (OTSR)
enroute ship weather forecasts (WEAX)
refractive effects
ballistic wind and densities
amphibious forecasts
environmental briefings
climatological studies
optimum path aircraft routing (OPARS)
acoustic predictions
search and rescue (SAR)

Figure 3

IV. NATURE OF THE PROBLEM

A. PAST HANDLING OF PROJECTS

In late 1976 FNOC adopted a computerized descriptive list of projects. This listing was originally developed for use exclusively by the Data Integration Department. This action constituted the first step in the development of a MIS to assist in project control. This list was only a beginning and fell far short of fullfilling the needs of the command. Due to other commitments and limited resources, little progress was made in improving the system. There were several serious problems with the system; the report format was not well defined, file updates were irregular and incomplete, and milestone dates were passed without comment or explanation. A serious problem worth discussing, was the fact that the system lacked middle management support. The primary reasons given for dissatisfaction with this MIS were that it was a cumbersome and ill-defined system and that it provided very little, if any, benefits to the middle manager.

The MIS received considerable command attention between 1976 and 1977; however, commitment of personnel resources to

solve its many problems was lacking. After this period the MIS received only ocasional command level emphasis and by mid 1979 there was considerably less insistence on keeping the information updated. By 1980 the commanding officer had taken the MIS out of operation completely.

It would seem that, by all development standards, this MIS was doomed from the start. Installing an information system is a complex job. It involves an examination of the entire structure of the organization and the information flow. Clearly, this was not done in this case. The need exists for more planning and some definite attention to the organizational problems.

B. CURRENT HANDLING OF PROJECTS

Currently there is no automated MIS, neither are there any well-defined procedures for project control and reporting.

Several manual reporting/tracking mechanisms have been tried recently, including the completion of the form in Figure 4. These represent major milestones/tasks to be accomplished during the periods indicated. These tasks are listed by department, staff position, and major projects. Although only a crude mechanism; it does force involved personnel to give some thought to their own priorities in

relation to the command's priorities. The problem is, all personnel involved do not contribute; therefore the information is not complete.

A second mechanism currently in use is the Projects and Plans Summary, Figure 5, initiated during the spring of 1981. The Plans and Programs Officer has identified 8 general project areas based on function; within these areas there may be many projects. This summary identifies primary resources involved and scheduled events, activities, and milestones for the current fiscal year and beyond. It is strictly a manual effort and the initial summary took three days of concentrated effort to produce (this time does not include its planning time). These dates are monitored using strictly manual methods which requires constant vigilance and attention to detail. It is highly likely that when the current Plans and Programs Officer leaves FNOC (in the fall of 1981) this summary will cease to exist.

Reporting of development projects is handled via the Work Unit Package which is submitted twice a year and updated only for major changes. This report is produced on a word processor; however no data manipulation is done. This is due in part to references 24 and 25, which

specifically prohibit use of word processing equipment for data manipulation without prior approval.

C. FNOC PROJECT ENVIRONMENT

FNOC utilizes a matrix organization for project management. Figure 6 represents the general structure of this organization, while Figure 7 depicts FNOC's operational organization. Matrix management is based on the concept of pulling together technical and managerial talent into a team to operate without the limits of discipline or organizational lines. Matrix relationships are far more complex than traditional functional relationships in which the relationships are predominantly vertical with few, if any, cross-functional aspects. Each major group or department is primarily concerned with its own goals. The matrix organization changes these traditional patterns by creating new vertical, horizontal, and diagonal relationships among its members. Communication becomes far more critical in a matrix organization; thus, tight project control and reporting becomes increasingly crucial.

The department head's goal orientation must also change due to the matrix organization, in that they must be concerned with project goals in addition to their functional goals. [Ref. 11] In a matrix organization, the functional

specialist is placed in the difficult situation of taking direction from two managers; therefore, if there are not well defined channels of authority, there is potential for considerable conflict. Irregardless of this, due to the nature of the project environment, matrix management appears to be the proper choice. The built-in conflict, if handled properly, tends to enhance initiative among the participants as they compete for the limited resources.

Matrix management is indeed difficult; however, it facilitates the coordination and integration of many project activities, and provides the flexibility required in a complex multifunction environment such as FNOC.*

Two staff positions were established to aid in project planning and control. The PLans and Programs Officer, responsible primarily for long range planning and budgeting, and the Development Coordinator, responsible for coordinating R&D activities under work unit funding.

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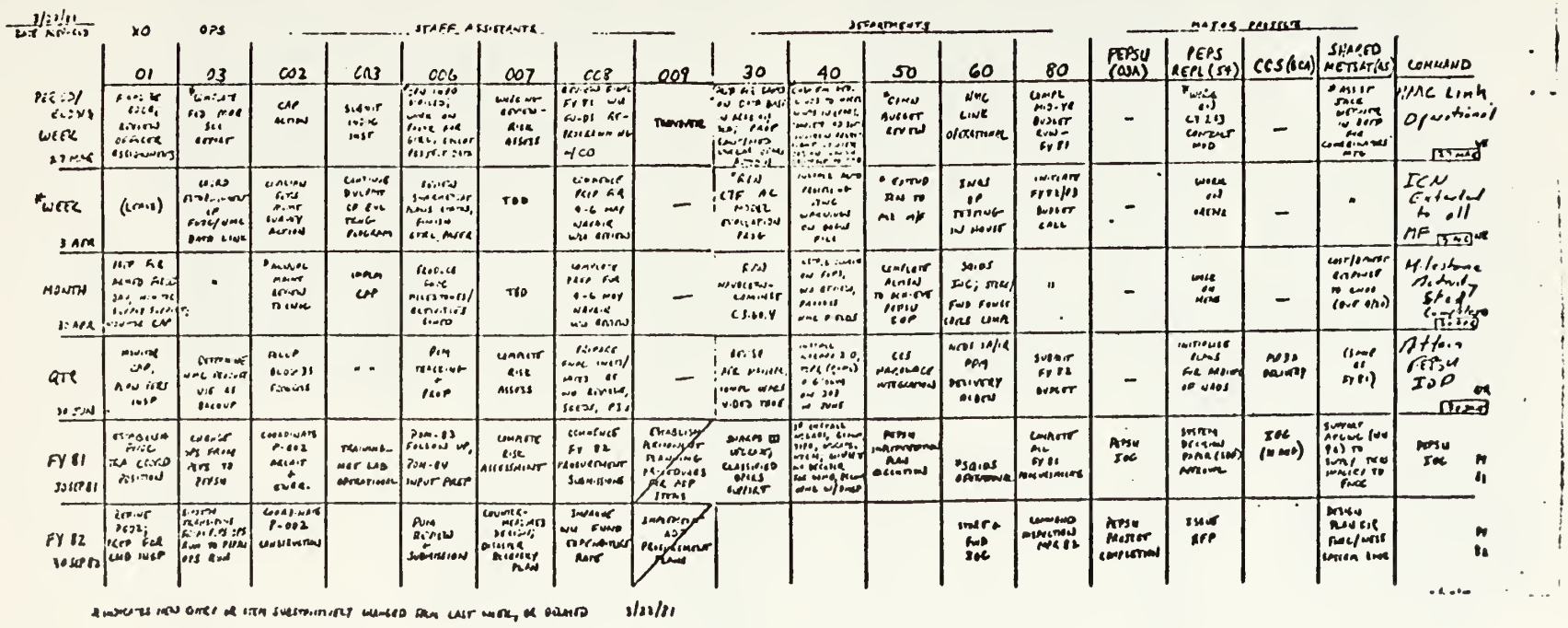
*For additional reading on matrix management consult reference 11.

FNOC PRIORITIES



3/23/81 DATE REVISED	XO	OPS	STAFF ASSISTANTS						DEPARTMENTS						MAJOR PROJECTS				
	01	03	C02	C03	006	007	CC8	009	30	40	50	60	80	FEPSU (03A)	FEPS REPL (54)	CCS (BCA)	SHARED METSAT/GS	COMMAND
PERIOD/ CLOSE WEEK 27 MAR	Review SITREP, Review Officer Assignments	*Complete FY83 POM Sub Either	CAP Action	Submit Topic Input	Plan Info Papers; work on Issue for Brief, Enlist Assistance	Work WC Review - Risk Assess	Review Env. FY81 Use Go-No Re-Release w/CO	TRANSFER	Plan All Exer on C3CM Basis w Assess Rpt; Prep Completed Exercise Lessons Learned	Review Pro- to Ensure Inclusion; Insert Op Tasks; Identify Req for Exercise Support	*Final Budget Review	WWC Line Operations	Complete MID-YR Budget Review - FY81	-	*Work on CY 83 Contract Mod	-	* Assist Shore Detachs in Prep for Conferences Info	*JTAC Link Operational 27 Mar
*WEEK 3 APR	(Leave)	Lead Finalization of Force/WMC Data Base	Finalize Plans for Early Action	Continue Development of Eval Trng Program	Review Submissions, Finalize Eval Paper	TBD	Complete Prep for 4-6 May Warfare Wk Briefing	—	*Plan CTF AC Model Evaluation Phase	Review Proj Resources; Sync Workload on Board Files	* Extend JAN to All Hqs	Issue OP Tasking in House	Initiate FY83/87 Budget Call	-	Work on Agenda	-	*	ICN Extended to all MF 5 Nov
MONTH 30 APR	Help Fix Board Pres; Sec. Work Flow; Review CAP	*	*Annual Maint Review to Wing	Update CAP	Finalize Sec. Milestones/ Objectives Issued	TBD	Complete Prep for 4-6 May Warfare Wk Briefing	—	Plan Wargame-Exercise CJ-60.V	Review Issues on Files, Wk Efforts, Possible Wkg P Pres	Complete Action to Review FEPSU ESP	Issue IOC; Stick/ End Focus Cycle Limit	"	-	Work on Agenda	-	Contractor estimate to cmpl (Oct 81)	Milestone Activity Sheet Complete 15 Apr
QTR 30 JUN	Monitor CAP, Plan Fleet Insp	Optimize WMC Review Use of Backup	Follow Blocks 33 Focuses	" "	Plan Preparation of FEOP	Complete Risk Assess	Finalize Final Input/ Mods of Wk Briefing, Issues, Pres	—	Brief SR Air Division, Issue Wkg Video Tape	Initial Analysis 3 Q, TPE (Typhoon) 6-8 June or 20 Jun Jun	CCS Hardware Integration	Need 10/A PPA Delivery Order	Submit FY 82 Budget	-	Initiate Plans for Mode of Ops	POD Delivery	(Time of FY81)	After FEPSU IOC
FY 81 30 SEP 81	Establish Process TCA Covid Position	Change SPS Form Ops to FEPSU	Coordinate P-002 Relief & Evac.	Training Met Lab Operational	Pom-83 Follow Up, Pom-84 Input Prep	Complete Risk Assessment	Commence FY 82 Procurement Submissions	Establish Requirement Training Procedures for AEP Items	Shakes III Update; Classified Ops Support	If Decide Update, Issue Info, Guidance, Wkg Mtg, Issue Wkg Mtg w/Brief	FEPSU Implementation Plan Approval	*Solids Operational	Complete All FY 81 Requirements	FEPSU IOC	System Design Plan (SDP) Approval	IOC (1 Nov)	Support Advise (on 9A) to Sum/ Two Inputs to FNOC	FEPSU IOC FY 81
FY 82 30 SEP 82	Review Pers; Prep for CNO Insp	System Training for Ops Use to Plan Ops Risk	Coordinate P-002 Submission		Plan Review & Submission	Complete Risk Assess; Develop Disaster Recovery Plan	Influence Wk Fund Expenditure Rate	Implement AEP Procurement Plans				Start & End IOC	Complete Disposition Mk 92	FEPSU Master Completion	Issue RFP		Design Plan (SDP) Finalize/Issue System Spec	FY 82

* Indicates new entry or item substantively changed from last week, or deleted 3/23/81

FIGURE 4

PROJECTS + PLANS SUMMARY — as of 4/30

Project/Plan Title: SATELLITE DATA PROC + APPS

Subprojects included: SHARMETSAT/HSCS, SPC mods, GOES/GADHS, DMSP,

Cog: 40/PIs Primary resources involved: ☐ O+MN ☒ OPN ☒ People ☒ Work units 9.1, 9.2, 9.4, 9:6

Scheduled events/activities/milestones:

FY 81

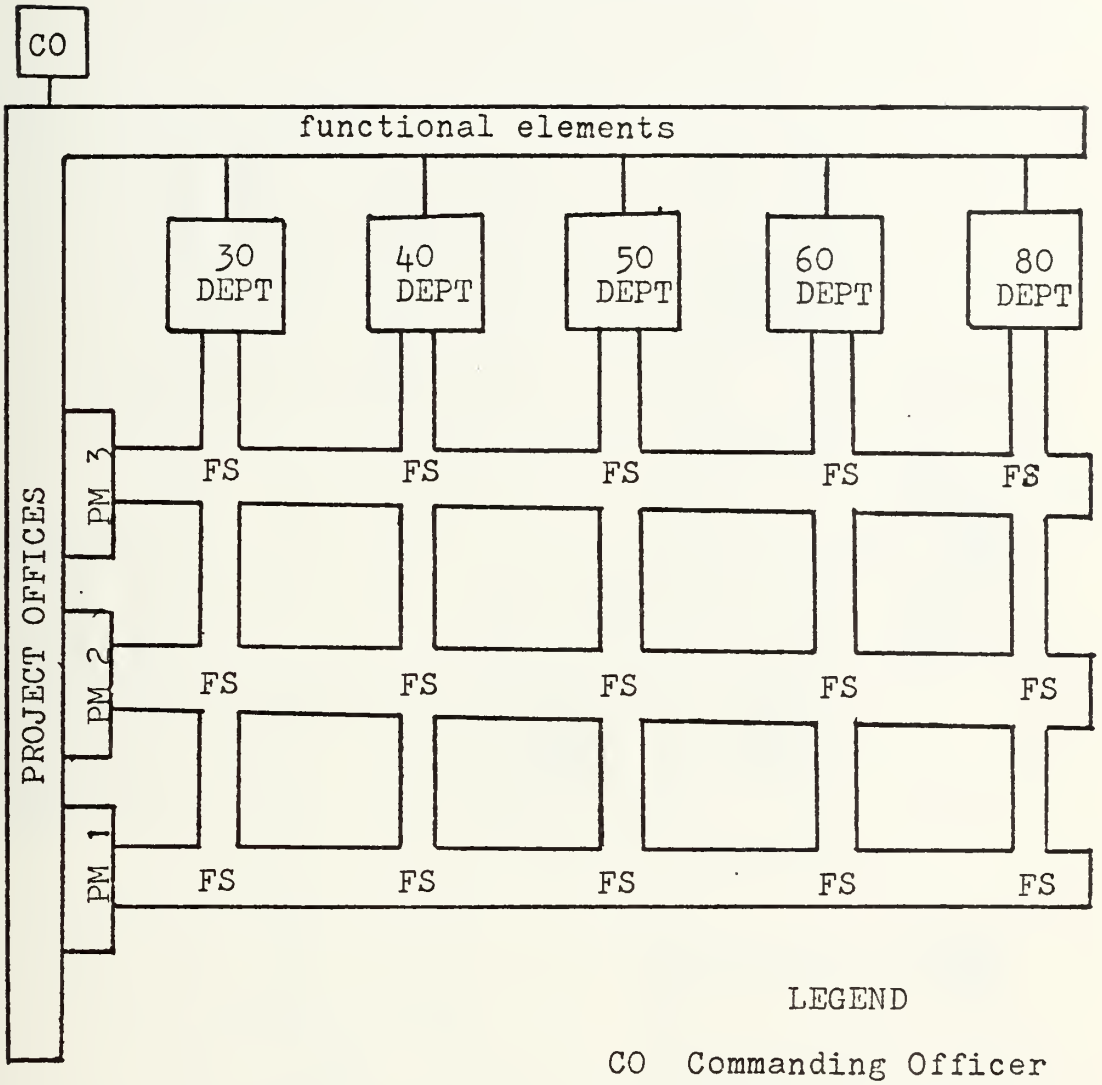
WHEN	WHAT	WHEN	WHAT
Sep 81	Update OPREP, PPM, SATDATARQ	Apr 81	Submit S/MS downlink eval to CNOC
Sep 81	Inst/ EHCO mods for I-I interface		
May 81	Accept/inst/ SSM/I Software		
–	Upgrade NIMBUS-7 apps software		
–	Implm NIMSAT/SAP2		
–	Upgrade SEAFORM SST/winds (SDDS)		
Apr 81	Commence procure GADHS sw for SPC		
June 81	Procure GADHS test + QC procedures		
Sep 81	Procure GADHS SST/Mercator transform		
–	Sat imagery (TYPHON) sw mods		
–	GADHS maint training at FNOC		
–	Acquire network adapters for IQIDS/GADHS		

LATER

WHEN	WHAT	WHEN	WHAT
		FY 84	S/MS uplink from FNOC activated
FY 83	S/MS downlink to FNOC activated	FY 85	SPC ECS enhance
FY 82	Initiate SHARMETSAT design contract	FY 84	Estab FNOC/NOO link interface
FY 82	Initiate minicomputer sys procurement to interface NESS w/SPC via RCA		
Apr 82	Update VTPRS for DMSP F6		
Jun 82	Implm CLOVEC		
Aug 82	Implm moisture ingest model		
Sep 82	Implm DMSP ltd area sea ice prgm		
Sep 82	Implm DMSP QC capab		
FY 82	Upgrade/update NIMBUS-7 apps		* "sw" = software
Dec 81	Install GADHS software for SPC		
Feb 82	Test Phase II GOES/GADHS, less NAD		
Mar 82	Dev ORSCHK/OPEVAL procedures (GADHS)		
Jan 83	Install GADHS NAD		
Apr 83	GADHS ORSCHK/IOC/OPEVAL		
Sep 83	GADHS documentation complete		
FY 83	Inst/ NESS/SPC interface via RCA		
FY 84	Desgn/Impl SHARMETSAT princ. recms.		
Apr 84	Implm SSM/I sw for DMSP F8		
FY 84	SPC disk enhance		

FIGURE 5

FNOC PROJECT MATRIX ORGANIZATION



LEGEND

CO Commanding Officer
PM Project Manager
DH Department Head
FS Functional Specialist

FIGURE 6

FNOC OPERATIONAL ORGANIZATION

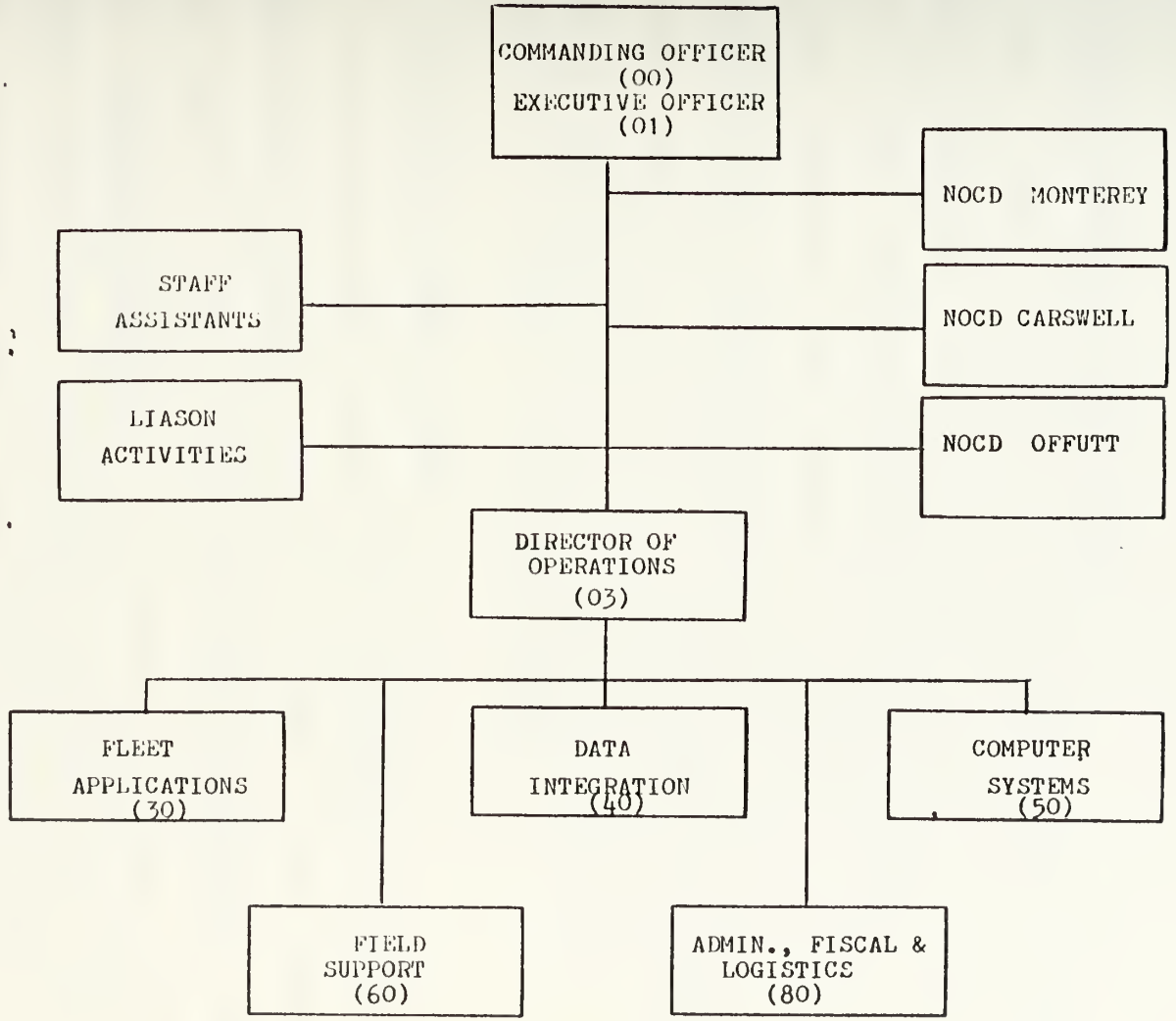


FIGURE 7

V. METHODOLOGY

This study focused on the identification of user requirements for PICS.

A. IDENTIFICATION OF THE PROBLEM

The initial concentration of this thesis was to formulate and describe a problem statement for project management at FNOC. Further discussion then focused on the various causes that had combined to produce the problem. The discussion also presented details about the past and current project management procedures . Having made a largely subjective determination of the problem, the next step involved an analysis of the user's needs.

B. ANALYSIS OF USER'S NEEDS

Twelve key FNOC personnel were selected on the basis of their senior management positions at FNOC or their expertise and longevity in the project management environment. Individual PERSONAL INTERVIEWS were conducted with each of the tweleve individuals. The question posed was; what information requirements and/or capabilities would you like to see in a project management and control system at FNOC (either automated or manual). Individuals responses were not

revealed to other interviewees and the interviewer limited her input, so as not to impose her views on those being interviewed.

Responses from interviews were consolidated in an unedited CHECKLIST form and distributed to all FNOC personnel directly involved in project management at some level. Those involved in the personal interviews were also asked to complete the checklist inorder to validate the information and assure that the interviewer's interpretation of their original responses was correct.

C. ANALYSIS OF REQUIREMENTS

Check list responses were classified as to management level (CO/XO/ DEPT HEAD/PRINCIPAL INVESTIGATOR/PROJECT MANAGER) and analized. Items that were not felt to be necessary were deleted and a comprehensive list of requirements was identified as the minimum necessary for a Project Information and Control System (PICS).

D. REVIEW OF SOFTWARE PACKAGES

The criteria to be satisfied by a project managment software package was outlined and a survey of available software packages was made. Each software package was compared to the established criteria to select the most appropriate package/packages.

This preliminary screening was based on the established general system requirements. The intention was to reduce the number of packages being considered to those that appeared most likeley to meet the needs of the organization.

E. PRESENTATION OF ALTERNATIVES

A variety of feasible alteratives were identified in an attempt to cover the entire spectrum of possibilities. Their advantages and disadvantages were examined and discussed to give the executive a view of their relative value.

VI. REQUIREMENTS

A. OBJECTIVES OF THE PROJECT INFORMATION AND CONTROL SYSTEM

The overriding objective of most organizations in implementing an automated information system, is to increase the overall effectiveness of the organization involved. In the private sector, this translates into increased profits. In the public sector, it is not as easily measured.

In order to define more specific objectives for the automated system, the author conducted personnel interviews with FNOC personnel. These interviews, together with the author's personal experience, were then used to describe the following overall objectives for an automated project management and control system.

1. Must require minimal inputs to the system, that is, once the initial system has been established, it should be no more cumbersome to maintain then current record keeping.
2. Must deliver information to the appropriate manager when it is needed, so that situations requiring immediate decisions can be controlled, and situations that are not pressing can be deffered, but not to the point of loss of control.

3. Must provide for simultaneous horizontal and vertical dissemination of necessary information, so that top level management and every operating department, will be adequately informed. In particular, it is important that the vertical dissemination of information follow only the necessary path. Furthermore, information sent in a vertical direction should be directed only as low/high as required to make or retract a decision.

4. Must reduce reams of information to meaningful facts for management to use in planning the future operations of the organization.

B. USER INFORMATION REQUIREMENTS

One of the first steps in developing or obtaining a software system, is to define the user's requirements. This is far more involved than it sounds. After almost twenty years of attention, it is still often the case, that computer based application systems are developed behind schedule, over cost, don't do as much as promised, and don't satisfy the user needs. At the heart of this problem, is the fact that, often the requirements for these applications were never stated accurately or completely in the first place. The fact that one may never reach perfection in this area

should not prevent an all out effort to identify requirements as completely as possible.

The importance to project success of getting these requirements right, can not be over stated. If the requirements are not complete or correct, the system may not be usable. If the system is salvagable, the cost incurred in correcting the system may be excessive and the additional time required, could be time better spent elsewhere. There is also the possibility that the organizational effectiveness will be decreased, due to either not having a workable system, or having one that only partially meets their needs.

Certainly our record of customer satisfaction is not good. For that reason, we must be aware of the problems and recognize that a substantial number of errors will exist in most requirements statements, unless specific action is taken to identify and remove them [Ref. 12].

There are three basic approaches to information requirements analysis [Ref. 13].

DIRECT ANALYSIS, which involves interaction with the user to identify decision processes and information elements.

INDIRECT ANALYSIS is the evaluation of data utilization, such as observing people or reports, in order to infer information requirements.

HYBRID ANALYSIS, which is a combination of direct and indirect.

The author utilized the hybrid analysis approach, together with her personal experience. It must be emphasized however; that this is simply a preliminary analysis of user requirements, and that a more extensive analysis should be undertaken if the decision is made to pursue this idea further.

Information for data items was collected from interviews, check list responses, and the author's experience. It was not felt necessary to include every data item from each source of information. The amount of effort needed to obtain and enter some items of data, coupled with the increased storage, capacity necessary, and subsequent longer retrieval times, far overshadowed the possible benefit that could be gained from having that information on line.

The author's value judgements were used to define a comprehensive requirements list that would be useful without being overly demanding on resources. Future evaluations of update and usage rates of these data items should be made once a system is in use, to reduce the size of the database by eliminating unused items.

The following are deemed minimal information requirements for an automated project management and control system.

* A means of establishing and tracking milestones, actual versus planned.
* A method to provide information on available resources, personnel, monetary, and computer, and their utilization and/or allocation.
* A means of indicating priority of projects.
* A means of establishing and promulgating lines of authority and responsibility.
* The ability to include narrative comments.
* A means of indicating time/scheduling information.
* A means to break the project up into tasks and subtasks for tracking and reporting.

Reference 14 and appendix A , contain more detailed requirements for recommended data elements.

It is recognized that these requirements differ with each level of management as does the degree of detail of the information. Anthony, [Ref.15] in his framework for planning and control, focuses on three categories of decisions which can be translated to the levels of project management at FNOC. They are:

STRATEGIC PLANNING: which is equivalent to the type of decisions made at the staff level (CO,XO,staff

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*CRAS (Computer Resources Accounting System) will provide information related to EDP usage.

assistants). They require only summary level information rather than more detailed reports.

MANAGERIAL CONTROL: the key concern here is that resources are obtained and used effectively and efficiently to accomplish the defined objectives. In FNOC's project environment this can be equated to the principal investigator and department head. They require details of resource utilization and milestone information.

OPERATIONAL CONTROL: at this level of decision the emphasis is on assuring that tasks are carried out effectively and efficiently. This equates to the project manager level at FNOC. The project manager is concerned with the day to day operations.

In order to provide the flexibility necessary to meet the diverse needs of the various users, this information should be accessable according to a number of retrieval criteria, such as:

* miletones exceeded
* upcomming milestones
* funding source
* responsible principle investigator,department,division
* name of project manager
* system relationship (ie. PEPSU, CCS,NEDS)
* priority
* estimated cost
* duration of projects

* classification of projects (ie. development, operational, or maintenance)
* resource allocation exceeded
* noncompliance with established update schedule.

C. GENERAL SYSTEMS CAPABILITIES

Aside from the information requirements listed in the previous section, there are a number of desirable capabilities the system should have. They include the following, which are listed according to relative importance:

* The ability to run on equipment currently available to FNOC.
* Easy/fast update procedures, requiring little or no additional effort on the part of project staff.
* At least 3 levels of reporting; summary, detailed and exception. To assure that only that information of interest to a particular management level may be presented. Ackoff, [Ref. 16] emphasizes that contrary to popular belief, managers suffer most from information overload rather than lack of information.
* A means to control who is authorized to update/modify project information in the file.
* Backup/recovery procedures
* Flexibility in report formats to allow individual managers to get the information they require in a form that is most usefull to them. It is critical that middle managers receive some direct tangible benefit from the project management and control system if they are to support it.
* Specific definitions (ie. project,task, subtask,milestione) so that all reporting is done in regards to a common basis.
* Interactive capability option
* ability to support multiple users in the interactive mode.

VII. SOFTWARE PACKAGE REVIEW

Commercially available software packages are becoming a major market factor in the data processing industry. They have many advantages over independently developed applications. Most packages are well designed and documented and if the package has been on the market for some time, there is a good chance that most of the serious bugs have been eliminated. Software packages permit the installation of a new system for relatively less cost than that of in-house development due to the fact that the cost can be spread over many customers. There is little or no risk of cost or schedule overrun usually associated with software development efforts. This allows management to establish dependable schedules for implementation and accurate budget plans.

The purchase of a software package also allows the organization to utilize the professional talents of their programmers and systems analysts in the development of systems unique to their organization, rather than in redeveloping systems that have been developed by many before them. Additionally, if an organization deals with a reliable vendor, they minimize the risk associated with maintaining the

system. The organization's options are broadened in that if they do not have the skills or personnel available to maintain the system, they may call upon the assistance of the vendor (at the established rate).

There are a great number of software packages available that are marketed as aids to project management and control. These packages vary greatly in their scope. Some are designed to assist in the planning and tracking of only one project, others will handle any number of projects and provide a great deal of flexibility within the organization. The problem is that there are very few written in FORTRAN, the preferred language for implementation at FNOC.

The author found 3 packages that were available in FORTRAN. All 3 were eliminated from consideration because it was felt that they would not meet the minimum requirements.

PAC I is marketed by International Sysytems Inc. (ISI), King of Prussia, Pa. This package is designed to track only 1 project at a time and therefore was eliminated.

P.D.P.-E.D.M.S. is available from Control Data Corporation. This package was eliminated due to its strictly financial orientation.

OSCAR, marketed by On-Line Systems, Pittsburgh, PA., is available only in the time sharing mode.

Failing to find a suitable FORTRAN software package, the author chose to continue the search under the assumption that it was still feasible to purchase a software package and lease a COBOL compiler for less cost than in-house development. This idea will be discussed further in chapter 8.

An examination of the trends and the state of the art in computer programming and software package applications, along with a preliminary analysis of the information requirements of a project information and control system (PICS) at FNOC, provided a background for establishing the criteria for selecting a computer software package. Woodridge, [Ref. 17] suggested 4 categories for software selection criteria. These criteria address requirements in the area of features, technical and operational environment, implementation, and price of the package. The author used these 4 categories in the evaluation of the available packages.

A. EVALUATION CRITERIA USED

1. Features

The package should contain as many of the features described in chapter 6, section B as possible.

2. Technical And Operational

It must be possible to operate the package in the present environment. A thorough analysis of the technical and operational features of the candidate packages as they relate to the intended environment will assist in an appropriate package selection.

a. Hardware Configuration

The package must be capable of operating on the equipment currently available. This includes the available core memory as well as peripheral equipment (ie. card reader, plotter, printer, etc.) Mainframes currently at FNOC available include 3 CDC 6500s, a CYBER 175, a CYBER 203, a CYBER 170/720, and 2 PDP 11s.

b. Higher Level Language

A higher level language such as FORTRAN or COBOL must have been used to write the programs.

c. Operating System

The package should be capable of operating under the NOS/BE operating system.

d. Ease Of Use

The package must require minimal manual inputs. In other words; it should be no more cumbersome than current manual reporting , record keeping, and control mechanisms at FNOC.

e. Flexibility

incorporate selected current procedures and reporting formats.

3. Implementation And Maitenance

Two necessary requirements which ensure that the package can be implemented when needed and maintained with minimal effort are:

a. Immediate Availability

package must be available for immediate delivery and implementation, not in an under development status.

b. Supplier's Reputation And Business Integrity

The supplier must be responsive to it user's problems. They must be a well established company with a stable professional staff.

c. Training And Documentation

Documentation should cover the system, operations, users, data preparation,and programming. It should allow for ease of use and maintenance. Training should be availablae and a training manual available for inspection.

4. Price

Ideally, the package should be available to the user with no additional start-up costs.

Software directories and professional publications were searched to identify feasible candidate packages.

Many were eliminated immediately because they were not capable of running on CDC equipment. The following packages were thought to possess most of the desired capabilities and warrant closer review and examination by FNOC professionals.

B. INTERNATIONAL SYSTEMS' PAC II [Ref. 18]

1. General Information

International systems Inc. (ISI), King of Prussia, PA, has developed a sotware package for project management called PAC II. ISI specializes in automated project management systems. Pac II performs numerous and varied functions as depicted in Figure 8.

Pac II is a totally data base oriented system, consisting of 2 main modules. The planning module uses a single, easy to use input sheet. This module assists the user in directing and scheduling project resources. It supports a simulator capability with critical path identificiation, resource loading, and inter-project dependencies. Activities can be assigned to resources by skill, as well as by specific resource identification. In fact, PAC II is capable of making proficiency level distinctions.

The management module accumulates project progress information and makes available multi-level status, cost, and history information. A single turnaround document, which is designed by the user, feeds in the only information

PAC II FUNCTIONS

*budgeting	*resource tracking
*planning	*Progress reporting
*project simulation	*automatic audit trail
*critical path analysis	*status accounting
*scheduling	*project monitoring
*modelling	*cost accounting
*skill scheduling	*statistical analysis
*on line/real time	*graphics

Figure 8

necessary to report progress. The outstanding feature of this module is its ability to alert management early when problems occur. The user sets tolerance levels and the updated data base is constantly monitored. Should any of these limitations be broken, PAC II automatically alerts management and produces detailed reports for analysis and corrective action. (ie. projects more than x months late or cost overruns greater than x percent) This is a particularly desirable feature. Project managers are understandably very reluctant to admit their project is behind schedule. This automatic reporting facility alerts upper management of this type of problem.

Although not explicitly termed milestones, the same function can be performed by defining what the PAC II system refers to as "EVENTS". The PAC II system can be used to plan a single project or any combination of projects, Any number of activities or tasks with dependencies across project lines.

PAC II offers a variety of input methods: computer generated turnaround document, manual input forms, punched cards, terminal entry, or OCR. Table entries are used for those items of information that are placed on the file once only; but are used constantly (ie. skill codes, holiday schedule) . Use of table entries can save the user many repetitive entries and provides for ease of maintenance and modification.

ISI offers a seperate add on option, the PAC II Report Writer, a facility for accessing the data base and producing reports that have not already been programmed into the system. This facility allows the user to request reports in a format they specify. Inputs are made via simple English language statements. ISI also offers an interactive package which provides a terminal data entry and planning capability and a graphics package which offers users 2 different options: plotter or printer. These

optional software packages as well as the Report Writer option, may be purchased with the basic PAC II system or be added on at a later date if desired.

2. Cost Information

Prices in effect as of the writing of this thesis are as follows:

	buy	lease/purchase
PAC II basic system	$26,000	$15,600/yr
plus 1 time installation		$2,160
total	$26,000	$17,760
cost to purchase after one year*		$13,568
optional software available		
PAC REPORT WRITER	$4,000	$2,400/yr
plus 1 time charge		$ 330
total (1 year)		$2,730
PAC INTERACTIVE	$10,000	$ 6,000/yr
plus 1 time charge		$ 830
total (1 year)		$6,830

*70% of the first years lease payment and installation charge will be applied to reduce the purchase price.

Basic package price includes:

PAC II COBOL source programs (on tape)

PAC II maintenance and enhancements for 1 year

pre installation meeting

documentation
* implementation guide (2)
* coordinators case study (1)
* users reference manual (2)
* project leaders guide (2)
* input forms
* user reference cards (25)
* selection of turnaround documents

installation, checkout, classes and OJT.

3. Additional Information

PAC II is currently installed on CDC equipment in several areas. Contact was made with MS. Dee Thorne in the data processing department of Reynolds Electric and Engineering, Las Vegas, Nevada [Ref. 19]. This company was chosen because it not only has a PAC II package installed on CDC equipment; but it is also operating under the NOS/BE operating system. This organization has a CDC 6400 and a CYBER 74 operating in tandem. Reynolds is the prime contractor for the Nevada Test Site and as such, they utilize PAC II in a variety of applications, including R&D development.

Ms. Thorne indicated that they have received excellent response from ISI and that they are please with PAC II. They also purchased the PAC II REPORT WRITER option; but chose to develope their own interactive capability in-house.

Ms. Thorne is very agreeable to further consultation with FNOC staff.

C. NICHOLS' N5500 [Ref. 20]

1. General Information

In 1977 Nichols and company of Los Angeles, CA., developed a project planning and control system, currently marketed as N5500. PERT and precedence networking enable the Nichols system to constantly monitor the impact of slippages and plan changes on in-process projects. What-if simulation capabilities highlight the impact that proposed projects and/or changes will have on the current in-process work load. Critical path analysis and slack time indications provide the user the ability to optimize schedules and minimize resource waste.

The planning process starts with the user's definition of the organization's planning environment. This is accomplished through the use of a dictionary mechanism. This means this information need only be inputed once. the dictionary is maintained seperately from the rest of the data which makes validation and modification a less complicated task. The use of the dictionary also allows the system to be adapted to any life cycle methodology, work breakdown structure, or documentation standards. The use of

the dictionary mechanism also significantly reduces the redundant entry of data. This means a time and effort savings to the user.

The Nichols system, like the PAC II system, has an option for automatic assignment of resources by the system, which can be valuable to the planner. Changes to projects can be accomplished with remarkable ease. Tasks may be added, changed, or deleted at any time, and the impact of any change will automatically be shown on all related tasks and projects. Task changes only require that a project number, task number, and the revised data be entered.

Project control is accomplished through the distribution of work schedule reports use to publish work assignments. Each person or group then reports back the work done on each task during the week, the work remaining to be done on each in-process task for that week, and any comments they wish to call to the project managers attention.
The Nichols system has a mechanism where-by an overt error in a data field will not cause the system to stop performing. The system simply makes a best guess and executes the program regardless of the number or severity of these errors. Although these errors are flagged and continue to be flagged until corrected; this feature should be closely examined by FNOC analysts to determine if it is desirable.

The Nichols system offers 20 report formats as part of its basic system. These reports cover 6 major groupings: administration, project planning and control, resource load and distribution, history and committment of resources, performance analysis, and accounting. One output file interfaces with a plotter to provide critical path analysis. Other reports are in either tabular or graphical form and are easily read and interpreted. The Nichols system also offers an optional generalized REPORT WRITER add on to allow the user to design their own reports.

The weakness in the Nichols reporting structure lies in the fact that they measure progress via percent completed rather than milestones completed which can be very misleading. The variance indicators are a key attraction, drawing managements attention to areas that are off target.

2. Cost Information

Prices in effect as of the writing of this thesis are as follows:

	BUY	Lease/Purchase
N5500 Basic System	$25,000	$15,000/yr
plus 1 years maintenance	n/a	$ 1,000/yr
total (1 year)		$16,000
Cost to purchase after 1 year	n/a	$11,500

OPTIONAL SOFTWARE AVAILABLE (not available as lease)

REPORT WRITER	$ 5,000
Interactive	$10,000

Package price includes:

object code (source will be delivered on tape upon receipt of payment)

technical documentation (1)

user manuals (5)

5 days of on site training

input forms

1 year maintenance with purchase

3. Additional Information

Tektronics, a production facility that among other things produces terminals. N5500 was originally installed on a CYBER 73; but due to work load constraints, they switched to their CYBER 175. This action resulted in faster turnaround time. The operating system being utilized is NOS level 509.

Contact was made with Ms. Charlene Madiman, who is the data base administrator for the Product Safety Division. [Ref. 21] She is responsible for data entry and interpretation in support of the N5500 applications. Ms. Madiman indicated that they were very pleased with the N5500 package. Their input is done via terminal and then batched into the system for processing. All data entry and interpretation is done by Ms. Madiman and she says this is a full time job considering the number of projects/instruments she works with (over 350). Inputs from project managers is very straight forward and involves entries on a pre-printed form.

Only two negative aspects were reported. First, that the previous version of the user manual was difficult to interpret.* The second problem area was in the error handling mechanism. Errors are flagged and continue to be flagged until corrected; however there is no indication as to the type of error. Error correction may prove to be very time consuming if the error is not readily apparent.

Ms. Madiman indicated that their staff would be happy to discuss the package and its implementation further with FNOC staff.** Ms. Cindy Wong, marketing representative for Nichols, has indicated that there is a good chance that N5500 will be converted to NOS/BE for another customer in the near future [Ref. 22].

D. MSP's PROJECTMANAGER [Ref. 23]

1. General Information

PROJECTMANAGER was marketed originally in 1972 under the name PMACS. It is a batch processing system which maintains 3 major files: the resource file, the activity file, and the project files. Generally, the resource file and the activity file need only be set up once. The project file

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*Nichols has released a new version of the user manual; however Ms. Madiman has not used it long enough to evaluate it.

**Contact point is Imants Goltz, manager of software support, at (503) 627-4675.

activity file need only be set up once. The project file contains the project plan, estimates, progress to date, and new projects as required. Projects can be broken down into subproject levels called tasks.

PROJECTMANAGER requires periodic updating of work accomplished and costs incurred. The user selects the reporting period. Mandatory entries are resource, project, and activity codes. Optional entries include task, rate of pay, computer use codes as well as various expence categories and projection data items.

Input can be by card, or card image on magnetic media, paper tape, or on-line data entry. All input transactions are read into the system by a data validation program, which carries out exhaustive validation of each input record and rejects any erroneous data. A report is produced by the program so that all detected errors are clearly described to the user for correction and resubmission.

PROJECTMANAGER output consists of 3 main types: validation reports, file content listings, and user selected progress reports.

Validation reports are produced whenever data is entered. All input information is printed including error codes and pointers that identify incorrect items.

File content listings are obtained on demand in standard format and are of particular interest to those who control code allocation and related tasks.

Progress reports can customize the system to the needs of the organization. The number and type of the output reports is determined by the user.

2. Cost Information

The PROJECTMANAGER package can be purchased for $8,000. The package includes:

Object code (on tape)
1 days on-site training and advise
1 set of documentation

3. Additional Information

Because of the relatively low cost, this package was included for consideration, even though it has not been implemented on CDC equipment and will require some in-house effort. The package was written in COBOL for IBM equiment; but has been coverted to operate on Burroughs, Honeywell, and ICL equipement. A recent conversion from IBM to ICL DME/V took one user group 17 days. Larry Hagg, West Coast Region Manager fo MSP, has indicated that FNOC could obtain the source program at no additional charge, if they wished to convert the package themselves. [Ref. 24] The code should

be examined closely by FNOC analysts to determine if there would be any problem in conversion. Generally speaking, conversion of COBOL programs is relatively easy. The problem is that once FNOC makes this conversion, MSP will not be able to provide the maintenance.

E. OTHER PACKAGES EXAMINED

Other packages examined and subsequently eliminated are included here to assist FNOC in acquisition in the event that they choose to follow through on a PICS. QUICK TROL, marketed by Quality Data Products Inc., is written in assembly language and can not be adapted to CDC equipment. PROJECT MONITOR, Marketed by Program Products Inc, was unresponsive to requests for additional information. Information on PC 70, marketed by Atlantic Software Inc., was received to late to include in this analysis. It is recommended; however that should FNOC consider the purchase of a software package, Atlantic Software Inc. Be given an invitation for bid.

VIII. ALTERNATIVE COURSES OF ACTION

A. MANUAL ALTERNATIVES

The alternatives requiring the least time, effort, and resources are those that require little change to current methods; however these alternatives may not be the most desirable. Two manual alternatives are presented here because they are considered viable alternatives.

ALTERNATIVE 1: CONTINUE AS IS

The obvious advantage to this alternative is that it requires no effort and no cost. That is, no direct cost. It could cost in terms of the efficiency and effectiveness of the organization. With the exception of the work unit reporting, which is done twice a year, there is no formally defined reporting structure for project management at FNOC. Formal reporting permits ready comparison of progress with plans and ensures a uniformity and consistency of information throughout the project. It also provides a historical record of the project. Failure to keep adequate well structured reports makes it very difficult when others are forced to assume management duties. Personnel turnover at FNOC is high due to the military environment. It is therefore

critical that records allow the new project manager to trace what has been done and what remains to be done in the project. Many projects span several years, so the chance of turnover in project personnel is high. Use of civilians in key positions eases this problem somewhat; but does not eliminate it all together.

With no complete historical records of projects, FNOC will find great difficulty in presenting and defending their actions in case of contract dispute and litigation. Historical records of a project can also assist the project manager in planning future projects and hopefully, in avoiding mistakes made in prior projects.

ALTERNATIVE 2: ENHANCED MANUAL SYSTEM

Enhancement of the current manual system could serve to alleviate some of the problems noted previosly. This enhancement can take the form of in-house establishment of definitions and procedures or perhaps the purchase of a project management methodology.

In-house enhancement means those who establish the methodology will be intimately familar with the FNOC environment; however they may not have the project management expertise that might be available on the outside. Staff time will still be required to determine and put into effect

the methodology. This may be time that could be better spent elsewhere.

There are several methodologies marketed that would provide assistance in establishment of a project management and control system. Spectrum, marketed by Spectrum International Inc. of Los Angeles,CA., and SDM/70, marketed by Atlantic Software Inc. of Philadelphia, PA., are two such methodologies. Spectrums price ranges from $32,000. Price is dependent on the number of programmers and analysts that must be trained. For a staff of 40-50, the price goes up to $50,000 , which includes the 16 days of training. The SDM/70 price of $30,000 includes training and the availability of a 24 hour hot line. These prices are relatively high in comparison to the automated packages available. They also fail to eliminate a key problem, relating to timeliness and accuracy of reports. The amount of correlation and calculations needed to produce some reports preclude the use of manual methods. Speed and accuracy are vital parts of progress reporting and are primary benefits accorded by a computer.

B. AUTOMATED ALTERNATIVES

Projects involve the deployment of a number of personnel, equipment, and money, and the integration of activities

to achieve some predetermined aim. This means that these activities must have been pre-planned, and the degree of success achieved depends to a large extent on the effectiveness of the planning. There are many types of projects and activities that do not lend themselves to manual control methods, for example, those that involve a large number of organizations or people. Additionally, the interdependencies of the various parts of the plan may be to complex for an individual to monitor and traditional methods of representation (ie. bar charts or schedules) may not represent the plan effectively. Finally, the project may span long lengths of time, making it difficult to track manually. With these points in mind, it becomes necessary to consider alternatives that provide for some means of automated assistance for PICS. The following alternatives provide that capability.

ALTERNATIVE 3: IN-HOUSE DEVELOPMENT

There are several advantages to in-house development. First, the system must be acceptable within the user environment and to the user group. By developing it in-house there is a greater opportunity for user involvement. The user must identify the new system with their operational requirements from the start, this too is made more viable by

in-house development. Change needs to be self-motiviated if it is to be successful and long lasting. The organization must take the responsibility for and be committed to the new program.

In-house system development is rarely cost-effective when compared with outside purchase. Valuable system usage time is lost while the in-house system is developed. Due to the developmental nature, there is a degree of uncertainty as to the cost and schedule completion. Additionally, staff must be allocated to the development, who may be utilized more effectively on organization specific development (ie. oceanographic and/or meterological products). The maintenance/enhancement cost of in-house software is normally in the region of 50% of the original cost per year. While it is true that in-house systems may be geared more closely to the original requirements; this may make them less flexible when ammendments become necessary.

ALTERNATIVE 4: PURCHASE SOFTWARE PACKAGE

It would be advantageous to puchase a software package rather than suffer the expense and time delay that would be necessary to design and program a PICS specifically for FNOC applications. Because the vendor is able to spread his package development costs across a number of installations;

it represents a real discount on the investment required for a similar development in-house. Funds can be budgeted and an installation date scheduled with a great deal more certainty. The organization also gains the value of the vendors project management expertise and the experience gained by installations at other sites. Additionally, many of the software bugs will have been corrected. The problem is that the organization may not be as receptive to a package that will change their methods. It will be important to make the transition as painless as possible. Many of the packages allow the user to define terms and establish procedures consistent with those currently in use. The organization must assure that documentation is complete since they may be required to maintain it or puchase maintenance services from the vendor at additional costs.

Purchase of a software package will probably require purchase/lease of a COBOL compiler since very few packages are written in FORTRAN. Contact was made with Mr. Ken Gatliffe, local CDC representative, concerning pricing information. A COBOL compiler for a CYBER 170, 175 or CDC 6600 would cost $12,540 to purchase or may be leased for $310 a month plus a one time fee of $140 [Ref. 25].

ALTERNATIVE 5: REVIVE OLD MIS

The FNOC MIS system was originally designed for use by one department head and later adopted for command-wide use. It was not designed with the organizations overall objectives in mind. It was designed to fill a particular need at that time. The designer of the program and those that had been directly involved in its operation, have long since departed FNOC. Documentation is not complete and therefore revision and/or updating will not be an easy task. It will take a great deal of time for someone to become familar enough with the code to start to adapt it. Additionally, there are still some very negative attitudes remaining concerning this MIS . It was never well defined, inputs and updates were erratic, and the system only received sporadic attention by upper management. Not only did middle managers, who were required to submit the update information, not derive any benefits from the system; but they saw that upper management was not utilizing it. They saw their efforts as wasted, and when they did see any outputs from the system it was not current information.

This system required at least 1 full time administrator, although 2 would be more realistic considering the amount of data entry required. If the documentation were clear enough

and only minor changes were needed, this would clearly be an economical approach. The ramifications of the staff attitude problem is indeed difficult to predict.

ALTERNATIVE 6: DEDICATED MINI

Initially this alternative will be the most costly. Not only will the organization need to purchase the computer; they will also have to purchase or develop the software package. This alternative will, in all liklihood, take more time from decision to installation than the others. It will also require the involvement of more FNOC technical personnel in the acquisition, due to the hardware.

This alternative has several distinct advantages. Having a dedicated or semi-dedicated mini makes access easier and allows for continued operations when the main computer system goes down or is over loaded. It also allows the possibility of a wider selection of software packages. Greater benefits may be derived by utilizing the mini for other management and/or administrative applications, such as an inventory control system, electronic mail, etc. It also would open up a wider range of possible software packages for this and other applications.

IX. CONCLUSION AND RECOMMENDATIONS

Project managers are responsible for planning and scheduling various projects and assignments. They must face changing priorities and resources and respond appropriately. Changes and reevaluation of projects involving new priorities, resource availability (or lack of availability), new dependencies, ect. make management of on going projects a full time job.

A highly complex and expensive undertaking like a software development project requires careful planning. The project manager can not hope to schedule, measure, and control complex programming activity without a formalized, highly developed plan. All projects need planning. In most cases this involves a detailed breakdown of all the tasks which make up a project to ensure that realistic schedules of anticipated progress can be prepared. Each task needs to be of an easily identifiable and self contained nature so that measurement of progress is made as simple as possible. Within each task self contained check points must be established so that comparison of actual progress against planned progress can be made at meaningful intervals.

The only realistic way to be in control is to see regular evidence of progress (evidence of tasks/jobs completed). Documents to control projects must take into account a balance between the need for control; and the desire to keep form filling to a minimum.

One of the more important features of the project control system is the method of reporting. It should serve to formalize the kind of casual reporting that occurs in all organizations. Formal reporting permits ready comparison of progress with plans and ensures a uniformity and consistency of information throughout the project.

It is the author's opinion that FNOC needs a better defined and more uniform project information and control system. The current formal reporting mechanism and the informal reporting to the commanding officer, are neither adequate nor efficient. Verbal reports to the commanding officer are time consuming and may not be the best presentation mode. Presentation of one project without a view of how it fits into the overall project environment may give a distorted picture. Use of the word processor for anything other than processing textual information is not authorized, therefore correlation of information must be accomplished in some other manner [Ref. 26 & 27].

It is also the author's opinion that correlation and presentation of project information can best be accomplished by an automated PICS.

Based on information obtained in the preliminary analysis, the author's preference is for the PAC II software package. This is based primarily on 2 findings. First, the fact that this system has been implemented successfully on CDC equipment and the same operating system as utilized at FNOC. Additionally, this package appears to be flexible enough to meet current and possible fututre needs of FNOC.

Although it is the author's opinion that adoption of an automated project information and control system at FNOC is a desirable action; and that this action if properly implemented will enhance FNOC's effectiveness and efficiency; the following must serve to qualify this recommendation.

The first and primary consideration for implementation is that top level management at FNOC must make the decision to give full and active support to such a system. Without this support the system has very little chance for success. Positive action must be taken if requirements are not met by principle investigators and project managers. A steering committee, whose primary function is to review procedures and assure compliance, might be considered.

Once the decision is made to provide this support, an evaluation group, composed of programmers, analysts, project managers and principle investigators, should be formed. The Executive Officer and/or the Commanding Officer may also wish to be a part of this group since they are also users. Acquisition must go out for competitve bid unless sole source can be justified, which is unlikely in this case. Distributors of all packages reviewed offered demonstrations and/or presentaions of their package capabilities. It may be appropriate to allow vendors to make a presentation prior to the decision to automate. It would certainly serve to provide visual proof of what an automated system can and can not do.

Once a package is selected; it is recommened that in order to minimize the disruption, FNOC not convert in-process projects to the new system. It would be best to start only new projects on the new system. This will minimize the burden on the staff and management personnel and allow for a smoother transition.

The development and implementation of a project control system is, in itself a project. A great deal of extra effort is needed. Just how detailed any project control system becomes is a function of the system size and

complexity of the organization in which it is being applied. Generally, whatever the effort, the cost of a typical software development project is reason enough to justify it.

APPENDIX A

Requirements Checklist

GENERAL INFORMATION

This checklist is part of a study being conducted on project management and control at FNOC. The information on the following pages was acquired as a result of interviews conducted with a select group of key FNOC project personnel. The question posed was; what information requirements and/or capabilities would you like to see in a project management and control system at FNOC (either automated or manual).

The requirements listed on the following pages represent ONLY those that were mentioned during the personal interviews. The list, in all probability, does not cover all possible requirements. It is; however, a starting point.

The requirements have been grouped according to six general functional categories to facilitate an orderly presentation mode. This categorization was based strictly on the subjective judgement of the interviewer. Some of the requirements could very well fit into more than one of the categories; however they are listed only once for simplicity.

DIRECTIONS

Your cooperation is requested in reviewing and responding to the checklist items on the following pages. Each item requires two checks; one in response to whether or not you'll use the information and one in regards to how you would prefer it to be stored.

If after reviewing these requirements you can add to the list please do so; your input will be a valuable addition.

	DESCRIBE YOUR USE OF INFO			WHERE SHOULD IT BE STORED		
	NEED TO HAVE	NICE TO HAVE	WON'T USE	COMPUTER	WORD PROCESSOR	OTHER
********** *ARCHIVE INFORMATION * ********** NARRATIVE UPDATE CAPABILITY						
MEANS OF RECORDING/ DISBURSING KEY INFO						
PLANNING CYCLE/POM						
********** * TRACK ACTIVITIES * ********** MILESTONES (ACTUAL)						
MILESTONES (PLANNED)						
LIST UPCOMING MILESTONES						
FUNDING PROFILE						
********** * PLANNING ACTIVITIES* ********** PROJECT PRIORITY						
WAY OF DESIGNATING SUBTASKS						
WAY OF INDICATING DEPENDENCIES						
PERSONNEL ASSIGNED TO PROJECT						
PEOPLE RESOURCES AVAILABLE						
LOSS/TRANSFER DATA OF PERSONNEL						
WAY OF ASSIGNING ACTION ITEMS						
WAY OF INDICATING LINE OF AUTHORITY W/I PROJ						
CONTRACT INFORMATION						

	DESCRIBE YOUR USE OF INFO			WHERE SHOULD IT BE STORED	
	NEED TO HAVE	NICE TO HAVE	WON'T USE	COMPUTER	WORD PROCESSOR OTHER
********** * SUMMARY INFORMATION* ********** ACTIVE/INACTIVE STATUS OF PROJECT					
DATE LAST UPDATED					
PRIMARY INVESTIGATOR					
PROJECT LEADER					
PROJECTS ASSIGNED BY DEPARTMENT					
SECURITY SCREENING REQUIREMENTS					
STATUS OF RFP/RFQ					
PERS EXPERIENCE PROFILE					
CURRENT LIST OF COMMAND GOALS					
********** *ALIES RESOURCES DIST* ********** PERS HOURS/PROJECT					
HOURS/INDIV/PROJECT					
TOTAL HOURS/INDIVIDUAL					
COMPUTER RESOURCES AVAILABLE					
PROJECTS ASSIGNED BY INDIVIDUAL					
SPACE REQUIRED FOR PROJ STAFF &/OR EQUIP					
INDICATION OF SIZE IF SOFTWARE					
MACHINE HOURS USED					
ADP CONSUMABLES USED					

GENERAL CAPABILITIES REQUIRED

	AGREE	DISAGREE
AT LEAST 3 LEVELS OF REPORTING: SUMMARY DETAILED EXCEPTION		
MEANS TO CONTROL WHO IS AUTHORIZED TO UPDATE/MODIFY INFO		
EASY/FAST UPDATE PROCEDURES		
ABILITY TO ACCESS & PRINT A FILE, EVEN IF SOMEONE IS UPDATING IT (EITHER MINUS FILE BEING ALTERED OR WITH A WARNING MESSAGE)		
TWO MODES OF OPERATION: NOVICE/EXPERIENCED		
SPECIFIC DEFINITIONS (IE. PROJECT, TASK, SUBTASK, ETC.)		
MEANS OF FLAGGING INFO THAT SHOULD NOT BE DISPERSED INDISCRIMINATELY		
FLEXIBILITY IN GENERATING REPORT FORMATS		
BACKUP/RECOVERY PROCEDURES		
INTERACTIVE/ON-LINE CAPABILITY		

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